

TWENTY-NINTH MONTHLY  
**PROGRESS REPORT**

NOVEMBER 1 THROUGH 30, 1964  
TECHNICAL PROGRAM  
LIQUID OXYGEN AND FUEL PREVALVES  
FOR NASA SATURN PROGRAM,  
PRIME CONTRACT NAS8-5107

AE-9279-R

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A DIVISION OF THE GARRETT CORPORATION  
PHOENIX, ARIZONA



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INTRODUCTION

This report presents a summary of the progress in the design, development, manufacture, and test of the 17-inch liquid oxygen and 12-inch fuel prevalves tabulated below currently under development for use in the National Aeronautics and Space Administration Saturn Program.

<u>System Application</u>	<u>Valve Type</u>	<u>AiResearch Part No.</u>	<u>MSFC Specification</u>
Liquid Oxygen	All-Pneumatic	393692-3-1	20M32000
Liquid Oxygen	All-Pneumatic (less flowmeter)	393692-5-1	20M32000
Liquid Oxygen	Normally Open	395500-1-1	20M32010
RP-1 Fuel	All-Pneumatic	393694-3-1	20M32001
RP-1 Fuel	All-Pneumatic (less flowmeter)	393694-5-1	20M32001
RP-1 Fuel	Normally Open	395502-1-1	20M32011

The work was accomplished by AiResearch Manufacturing Company, Phoenix, Arizona, during the month of November, 1964. This report includes the status of the program at the start of the reporting period, a summary of activities during the reporting period, and a brief outline of future activities.



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The information contained in this report is intended for presentation to National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama, to define the technical progress for the reporting period in compliance with Appendix A, Item 1 of Contract NAS8-5107.

### STATUS OF PROGRAM AT THE START OF THE REPORTING PERIOD

The status of the program at the start of the twenty-ninth monthly reporting period (November, 1964) is summarized in the following statements.

1. Evaluation tests continued on the normally open liquid oxygen valve.
2. All Phase III fuel and liquid oxygen valves had been delivered to NASA.
3. Preflight certification tests had been completed on all configurations of the fuel pre valve, and preparation of the formal test report was complete.
4. Machining of the major valve components for Phase IV production units continued.
5. Calibration of flowmeters for Phase IV fuel valves had been discontinued pending resolution of the over-all flowmeter problem.
6. An investigative and test program was being conducted by Potter Aeronautical Corporation and AiResearch to determine the corrective action required to eliminate swelling of the rotor blades of the 17-inch flowmeters.
7. Preflight certification tests of the liquid oxygen valves had been discontinued pending resolution of the flowmeter problem.



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### SUMMARY OF ACTIVITIES DURING THE REPORTING PERIOD

#### Over-All Schedule and Progress

The over-all schedule and progress for the all-pneumatic and normally open liquid oxygen valves are shown on Figures 1 and 2, respectively.

Except for delivery of Phase IV production units, all phases of the fuel prevalue program (including design, development, delivery of Phase III preproduction units, preflight certification tests, and preflight certification test report) have been completed. In view of this, the bar-chart for the normally open fuel valve has been deleted from the progress report. Final program status of the unit is as indicated in last month's progress report (Figure 3 of AE-9278-R). Final program status of the all-pneumatic fuel valve is shown on Figure 3 of AE-9274-R.

#### Resolution of 17-inch Flowmeter Problem

An extensive investigation was conducted by Potter Aeronautical and the Aluminum Company of America to provide improvements on the new rotor design. As a result of this investigation, the aluminum alloy material of the magnet capsule was changed from Type 6061 to Type 5456, and the weld joint design of the capsule was modified slightly to provide greater penetration.

A sample rotor incorporating these changes was pressure tested with liquid nitrogen at AiResearch on November 9 and 10. Slight swelling of the capsules occurred on four rotor blades; however, the results showed vast improvement over the design tested during the previous period and indicated that closer in-process controls would be a significant factor in eliminating future problems.

To provide the necessary in-process controls, Potter Aeronautical Corporation obtained and installed facilities, fixtures, and equipment for in-process pressure testing both with high pressure gaseous nitrogen and liquid nitrogen. Process procedures were established wherein pressure tests

# PROGRESS TO DECEMBER 1, 1964

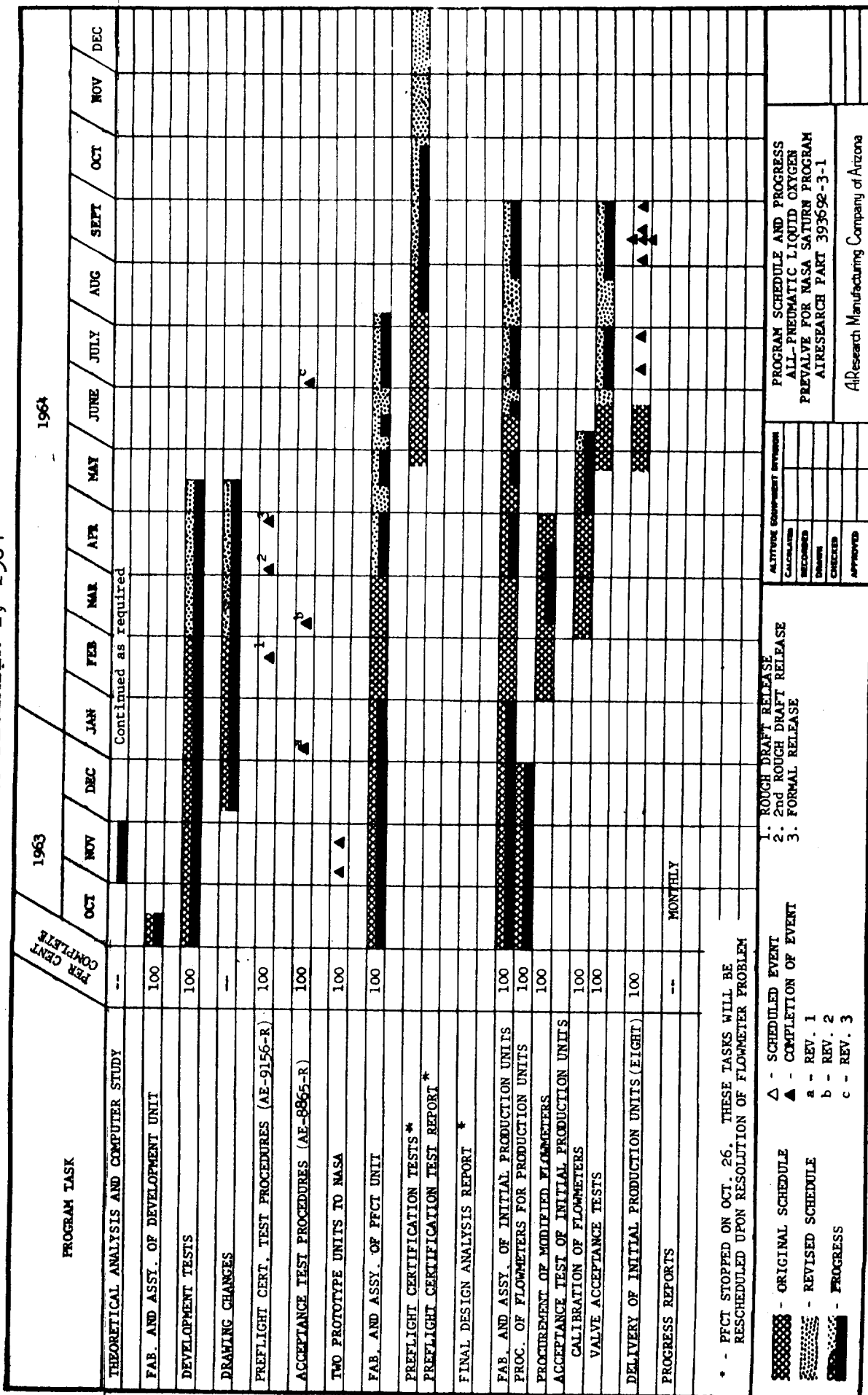


FIGURE 1

# PROGRESS TO DECEMBER 1, 1964

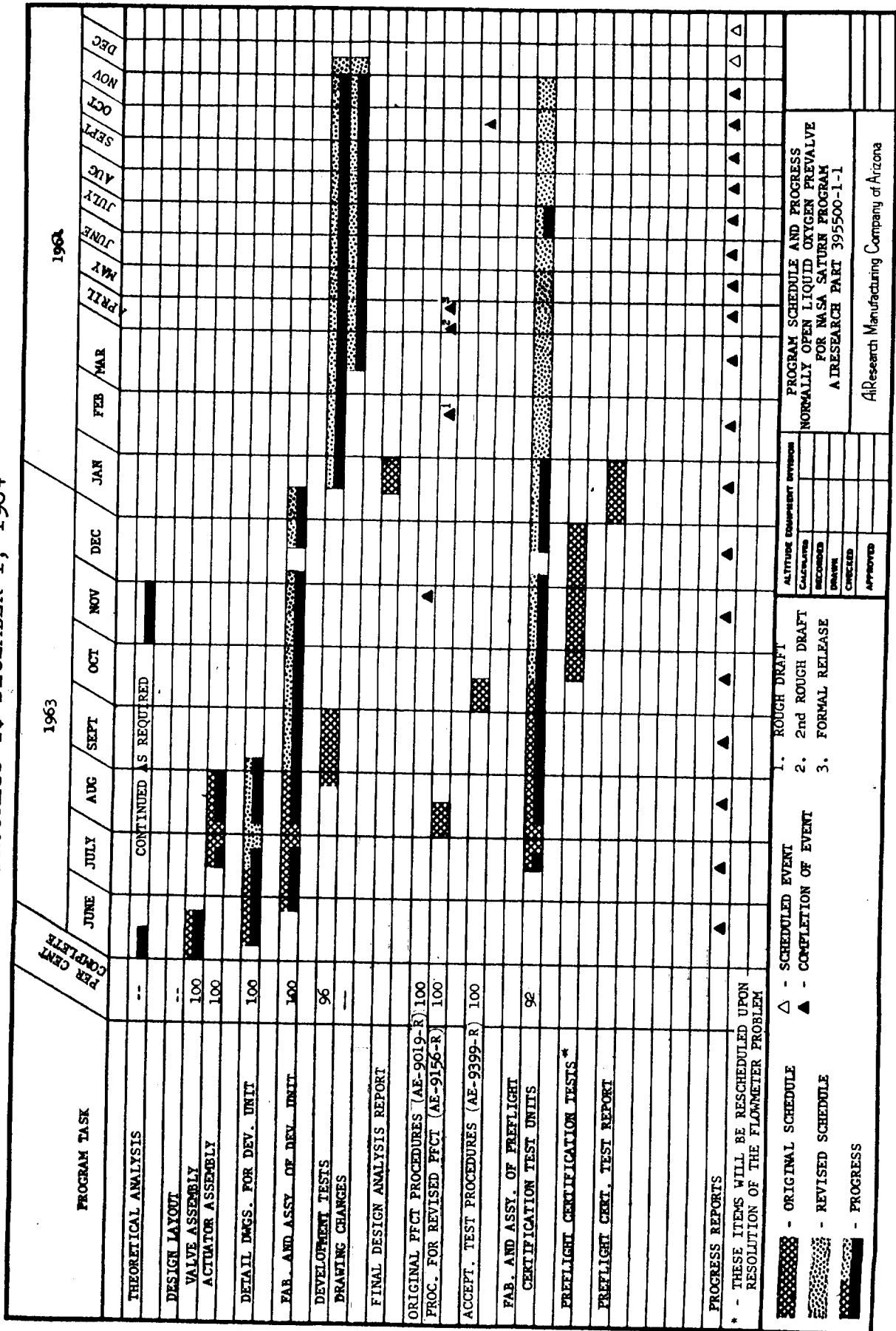


FIGURE 2



were performed on the encapsulated magnet subassembly following each machining operation, as well as upon the complete rotor assembly after shrink fitting of all capsules in the blades. In addition, receiving inspection tests at AiResearch will include pressure testing of each rotor assembly with liquid nitrogen.

The first flowmeter assembly incorporating the one-piece rotor fabricated to the above process controls was received from Potter and subjected to pressure cycling with liquid nitrogen. No swelling or deformation of the encapsulated magnets occurred.

Following successful completion of the pressure tests by the initial unit, Potter initiated action to expedite delivery of production units of the flowmeter. The initial five units are scheduled for delivery to NASA for installation in Phase III units following receipt and inspection at AiResearch and calibration at Wyle Laboratories.

#### 12-inch Flowmeters

Action regarding possible changes or modification of the 12-inch flowmeter was deferred pending directions from NASA.

#### Evaluation Tests of the Normally Open Liquid Oxygen Valve

Investigation of the improved mechanical latch for positive retention of the valve in the open position continued throughout the period. The new assembly incorporates a convoluted bellows to accommodate movement of the actuating plunger which disengages the latch arm, and eliminates the dynamic seal in the present piston-actuated design.

Layout and detail drawings of the new latch assembly were prepared and parts ordered. At the close of the period, parts were being received and inspected in preparation for evaluation testing of the assembly.





## Preflight Certification Tests of Liquid Oxygen Valve

No preflight certification tests were performed during the period. Preflight certification test activities, which were stopped in October pending resolution of the flowmeter problem, will be resumed when production flowmeters become available.

## Fuel Valve Preflight Certification Test Report

The changes requested by NASA and the NASA-signed title page were incorporated into the fuel valve preflight certification test report, after which the NASA-approved report was formally released for distribution. In compliance with the requirements of Paragraph 4.5.1 of Specification 20M32001, one reproducible and ten copies of the report, AE-9457-R, dated October 12, 1964, were submitted to NASA with AiResearch Letter PKNM-18400-1116, dated November 16, 1964.

## Design Activities

Fuel Valve Assembly Drawings 665368 (Rev. M) and 855294 (Rev. E) were revised to replace the plain lockwired nuts which retain the flow sleeve with lockwired self-locking nuts, thereby providing dual supplementary locking features.

In addition, the detail drawing of the Creavy backup ring used in the piston bridge seal of the liquid oxygen valves (Drawing 857120, Rev. D) was revised to increase the OD tolerance, for ease of manufacture.

## Phase IV Production Units

Procurement and machining of all component parts for Phase IV fuel pre valves were completed during the period. At the close of the period, final assembly of the two emergency drain valves (Part 393694-5-1) was initiated in preparation for acceptance tests and shipment of the units to NASA.

Machining of the major valve elements (inlet and outlet body and closure element) of Phase IV liquid oxygen valves continued throughout November. Fabrication and procurement of other component parts of the liquid oxygen valve were virtually complete.



### Contamination Control Areas

Installation of the additional and upgraded contamination control area for assembly of Phase IV production units continued throughout the period. A new 8 ft by 8 ft door had been cut through the existing permanent wall. The general area had been cleared and installation of steel framing for the new laminar flow room had been started.

The necessary modification of piping in the cryogenic laboratory and installation of one of two laminar flow enclosures were completed. The second test enclosure was received for installation at the close of the period.

### Miscellaneous Activities

Various other miscellaneous activities performed in support of the program are summarized in the following paragraphs.

1. Periodic Status Reports - Program status reports were submitted by TWX periodically throughout the month.
2. Engineering Drawings, Change Orders, and Parts List - The following engineering change orders and updated parts lists were submitted to NASA for approval during the period.

#### Change Orders

665368"L"  
665434"Y"  
855294"D"  
855295"F"  
857120"D"

#### Parts List

393692-3-1 "5A"  
393692-5-1 "1B"  
393694-3-1 "2D"  
393694-5-1 "1B"  
395500-1-1 "1F"  
395502-1-1 "1C"

3. Solenoid Valves - Two nominal 3/8-inch, three-way "Flowmatics" solenoid valves were received in the laboratory. These units will be evaluated for possible replacement of the Lanagan solenoid valves, which have proved to be unsatisfactory.



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### FUTURE ACTIVITIES

Program activities scheduled for the immediate or near future are summarized below.

1. Production of new 17-inch flowmeters by Potter Aeronautical Corporation.
2. Calibration and shipment of new 17-inch flowmeters to NASA for installation in Phase III preproduction units.
3. Resumption of preflight certification tests on the liquid oxygen valves, following receipt and calibration of the new flowmeters.
4. Continued evaluation tests of the normally open liquid oxygen valve.
5. Continuation of installation of upgraded contamination control areas for assembly of Phase IV production units.
6. Final assembly, acceptance tests, and delivery of Phase IV production units of the fuel prevalues (less flowmeters).
7. Continued machining and procurement of parts for Phase IV production units of the 17-inch valves.



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## APPENDIX 1

### TECHNICAL INFORMATION SHEETS

Technical information sheets prepared by AiResearch in support of activities performed during the period are listed below. A copy of each TIS is included in this Appendix.

<u>TIS No.</u>	<u>Subject</u>
A-640	Position Indicator Assembly for Use in Phase IV Units of Fuel Prevalves
A-641	Use of Locknuts for Retention of Flow Tube in Phase IV Fuel Prevalves

**NASA - MSFC**  
**MANUFACTURING ENGINEERING DIVISION**  
**TECHNICAL LIAISON OFFICE**

**MEMORANDUM FOR:** Mr. L. B. Marks, M-P and VE-PM  
Mr. W. Dunaway, PV and VE-PM

**SUBJECT:** Contract NAS 8- 5107 POSITION INDICATING ASSEMBLY FOR  
PRODUCTION UNITS OF FUEL PREVALVES

**REFERENCE:** Fuel Prevalve PFCT Report AE-9457-R, Paragraph 5.5.3.4

This technical information sheet is written to obtain NASA approval of incorporation into production units of the fuel prevalve the improved indicator assembly as used on the liquid oxygen valves. As discussed in detail in paragraph 5.5.3.4 of Report AE-9457-R, this improvement was made as a result of sticking of the indicator switches of the existing assembly experienced by PFCT units under low temperature conditions. The new assembly, identified as AiResearch Part 855868-351, provides the following improvements.

1. The new assembly incorporates Klixon Type 4AT7-1 open and closed indicator switches in lieu of Klixon Type 1AT-3 used in the existing assembly. The new switches have been designed and tested for operation at temperatures as low as minus 320F, as compared with the minus 65F rating of the existing switches.
2. Minimum shift in angular actuation and de-actuation of the indicator switches is assured in the new assembly by utilization of a ball-bearing cam follower to minimize frictional drag on the cam and cam follower, and by incorporation of a heavier leaf spring to provide additional force for positive actuation of the switches.
3. To avoid damage to lead wires experienced in vibration by the fuel prevalve test units, the new assembly includes better arrangement of and support for the lead wires. In addition, closer inspection of soldering operations has been initiated to eliminate spreading or "bird-caging" of the lead wires at the solder joint.

Suitability of the new indicator assembly for use in the fuel prevalues will be demonstrated during preflight certification tests of the liquid oxygen valve, during which the unit is subjected to test conditions and environments equal to or more severe than comparable requirements for the fuel valve application.

Accordingly, NASA approval of the use of indicator switch assembly 855868-351 in place of Part 855868-350 in production units of the fuel prevalues is requested.

**CONTRACTOR:** AIRESEARCH MANUFACTURING COMPANY OF ARIZONA

**PREPARED BY:** *L. I. Chambliss*  
L. I. Chambliss

**APPROVED BY:** *D. L. Cauble*  
D. L. Cauble

**ISSUE DATE:**  
11-12-64

**TECHNICAL INFORMATION SHEET**

**NUMBER:** A-640

**MANUFACTURING ENGINEERING DIVISION** Sheet 1 of 1

NASA - MSFC  
MANUFACTURING ENGINEERING DIVISION  
TECHNICAL LIAISON OFFICE

MEMORANDUM FOR: Mr. W. Dunaway PV and VE-PM and  
Mr. L. B. Marks, M-P and VE-PM

SUBJECT: Contract NAS 8-5107 Use of Locknuts for Retention of Fuel  
Prevalve Flow Tube

REFERENCE: Fuel Prevalve PFCT Report AE-9457-R, Paragraphs 5.5.5.5 and 5.5.5.6

This technical information sheet is written to obtain NASA approval for changing the flow sleeve retaining nuts to self-locking nuts.

As discussed in paragraph 5.5.5.5 and 5.5.5.6 of Report AE-9457-R, slight loosening of the screws (Part 855190-1) which retain the flow sleeve (Part 855827-350) occurred during preflight certification tests. In view of this, it is proposed that the plain lockwired nuts presently used on the flow sleeve retaining screws be replaced with lockwired self-locking nuts, thus providing dual supplementary locking features. NASA approval in this regard is requested.

As a matter of information, it is noted that the assembly instructions have been revised as follows to insure proper adjustment of the open position mechanical stop and thereby prevent possible contact between the trailing edge of the closure element and the flow sleeve retaining screws as occurred during preflight certification tests.

- a. A caution note not to allow the ball to fall freely to the open position with the actuator unattached has been added.
- b. Specific instructions have been added requiring adjustment of the open position mechanical stop to provide a clearance no less than 1/8-inch between the trailing edge of the closure element and the flow sleeve retaining screws. This clearance is to be provided after the actuator stroke and spring bottoming have been established.
- c. A specific inspection was added to verify that the minimum clearance is provided.

CONTRACTOR: AIRESEARCH MANUFACTURING COMPANY OF ARIZONA

PREPARED BY: *L. I. Chambliss*  
L. I. Chambliss

APPROVED BY: *D. L. Cauble*  
D. L. Cauble

ISSUE DATE:  
November 12, 1964

TECHNICAL INFORMATION SHEET

NUMBER: A-641

MANUFACTURING ENGINEERING DIVISION

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